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Chapter 4—Bioclimatism in vernacular architecture

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1. Vernacular architecture vs Representative architecture: the role of energy

Any analysis of the role played by energy in architecture is faced with serious limitations due to the lack of studies in the architectural bibliography, especially studies of popular architecture. An awareness of these limitations will allow us to understand better why architects have paid little attention to the interaction of form and energy, and to the bioclimatic approach in contemporary architecture in general.

The first limitation stems from the very essence of bioclimatic analysis; energy is immaterial, difficult to represent in images, changing in time and wrongfully left out of the architectural literature. This is why it is difficult to find a basic knowledge of the functional aesthetic possibilities of bioclimatism in the cultural experience of present-day architects.

The second limitation to this knowledge, even more important than the previous one, is the low value given to the more anonymous 'popular architecture' as opposed to 'representative architecture'. The latter is the kind of architecture built by established power, which attempts to impress the observer and clashes with, dominates, and often destroys the natural environment. This style of architecture is crammed with theoretical aesthetic concerns, which would rather create artificial environments than be integrated in the natural milieu. To sum up, it is the architecture undertaken by well-known authors, found in 'important' buildings, which have been commented and widely appreciated by architecture critics throughout history.

Nowadays, representative architecture can be said to describe the architecture found in large office buildings, which embody the legacy of such works from the history of culture as the pyramids, classic shrines, medieval castles and large Gothic cathedrals, baroque and Renaissance palaces, etc. These modern buildings, clad in glass as a symbol of their modernity, are incongruously dark and require artificial lighting during the day, while the flimsy casing separating them from the outside

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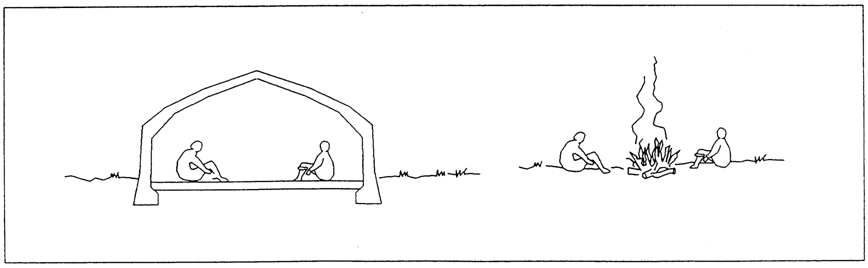

Fig. 1. Architectonic views: constructive or energetic.

makes it necessary to use air conditioning all year round, even when outside conditions are pleasant. We can well affirm that these buildings are so wrong that they 'work worse than the climate'.

In comparison with this type of representative architecture, we find popular architecture, performed by the people as a direct response to their needs and values. These buildings show a greater respect for the existing environment, whether natural or artificial. They do not reflect theoretical aesthetic pretensions and use local materials and techniques as far as possible, repeating over and over again the course of history models which take the constraints imposed by the climate fully into account.

Our popular architecture—so often forgotten in official circles—may well be the kind which can best teach us today how to assimilate the bioclimatic approach in the practice of architectural design. However, we should not consider these solutions to be models to copy in current architecture. Our technical capacity and our cultural grounding prevent us from returning to these obsolete architecture forms, but what may be of use as a lesson and a source of inspiration is the attitude of the builders of this popular architecture, which recovers a relationship to the environment which has been lost in the more official architecture of the 20th century.

2. General principles of the relationship between form and climate

Although it seems that any contemporary architectural design can solve its problems of environmental control by means of artificial systems, this is not completely true in our culture. Furthermore, in many other cultures buildings have been built (and are still being built) with an acute awareness of the limitations imposed by the climate in which they are located. Builders with few technical resources are forced to design their buildings in close relationship to their usefulness as a barrier against the climate. In our modern buildings, on the other hand, the unrealistic faith in artificial systems leads to designs which disregard the climate and turn out buildings that are both physiologically and psychologically inhospitable.

To study the relationship between climate and popular architecture, we should first of all classify the different types of climate found on the planet. If we make a simplified overall analysis, temperature can be considered to be the most representative parameter, both in its average values and in annual and daily variations. We consider

Fig. 2. Popular architecture and representative architecture.

humidity to be indirectly indicated by such thermal variations, since the greater the variation the greater the continentality of the climate, and thus the lower its humidity.

Looking at the most critical factors which affect the climate we will observe:

As regards the mean temperature, THE LATITUDE, with lower temperatures in places of greater latitude.

As regards temperature variation, CONTINENTALITY, which involves an increase in thermal variation and in the dryness of the climate.

Secondary factors, which modify the action of the previous ones, are:

ABSOLUTE HEIGHT above sea level, which as it rises entails a fall in the average temperatures and normally an increase in temperature variation and a fall in humidity.

TOPOGRAPHIC RELIEF, with countless microclimatic variations in its relationship to the sunshine and prevailing winds.

VEGETATION and HUMAN ACTION, which modify the results foreseeable according to the above factors, acting as a rule in opposite directions: greater thermal stability and humidity with the presence of vegetation and greater temperature variation and less humidity with the development of the natural land in human settlements.

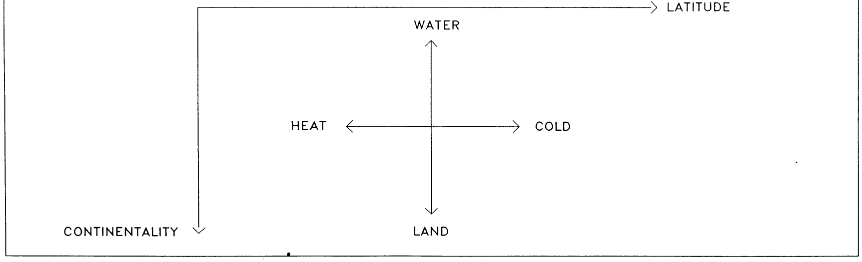

Fig. 3. Climate general classification.

The ensemble of all these factors means that there are marked local variations in the climate. There are also seasonal variations which can lead to the climate changing in a given place between extreme cases from the general field of possibilities during the year.

In spite of this, in order to be able to make a general analysis of the climate as regards its influence on the forms and solutions of popular architecture, we simplify the more complex reality by classifying climates into certain basic types which enable us to draw simple conclusions from architectural analysis. From this point on we will understand that any real climate is a weighted mixture of these basic types.

This simplified classification will let us observe that the most extreme cases of climate are those which have a clearer architectural solution, while the architecture found in temperature climates paradoxically turns out to be more complex, since the buildings have to adapt to changing conditions, and do not permit single solutions.

The foregoing allows us to distinguish three basic types of climate:

(a) COLD CLIMATES, typical of high latitudes or great heights in medium latitudes, with very low temperatures, seasonal variation with the changes of winter-summer sunshine levels, an always pleasant solar radiation and aggressive winds when they come from the direction of the corresponding pole.
(b) DRY WARM CLIMATES, typical of deserts close to the Equator, with high average temperatures and high temperature variations in the daily cycle, very low humidity and very directional solar radiation, no cloud cover and practically no rainfall, and dry winds which are warm, heavy with dust, and also very aggressive.
(c) WET WARM CLIMATES, typical of subtropical coastal regions, with high average temperatures and little day-night and seasonal variations, high humidity and heavy rainfall, high and relatively diffuse solar radiation, and variable winds which can easily be of hurricane strength.

To these three basic types, two further quite exemplary cases can be added:

(d) WINDY CLIMATES, which are found along with any of the previous cases with the presence of intense and frequent winds, or in temperate climates in which wind can become the main factor in the design of buildings.
(e) COMPLEX CLIMATES, as a rule temperature climates displaying, though with less intensity, the conditions of the previous cases in their variations throughout the year. In this case the greatest problem of architecture is its capacity to adapt to these changes by means of flexible solutions.

The solutions provided by popular architecture to the problems raised by the climate and its variations are interesting to analyze, as they make us aware of the fact that there are several ways to solve environmental problems, according to the influence of different cultures. These solutions have the special value that they reach a state of balance with nature that is never attained by representative architecture, perhaps as a result of making full use of limited technical resources. This has given rise to architectural cultures which have withstood the advance of many generations of users thanks to the basic correctness of their designs.

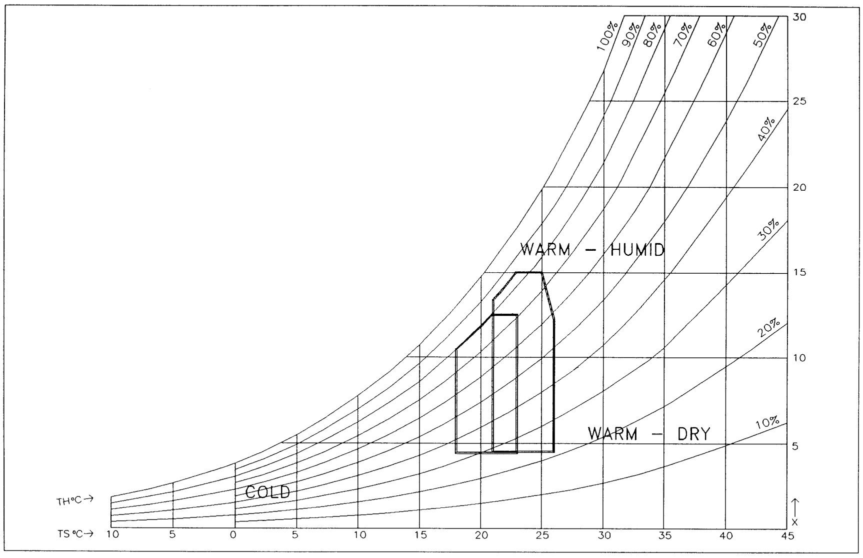

Fig. 4. Basic climates.

3. The richness of vernacular architecture

In popular architecture the climate is simply one more of the different forces (whether social-cultural, economic, defensive or religious, or involving the availability of materials, technical and constructive resources, etc.) that generate the forms of architecture. It is in conditions of low technology that the climate plays the main role and becomes the dominant force in the solutions used.

The more severe the climatic conditions, the more limited and rigid the solutions are. According to this principle, in very extreme conditions we should find unique solutions, the most useful, efficient and economic ones. However, reality does not work in this way, and in one and the same zone, with a given climate and conditions, we often find several solutions which solve the same climatic problems by different methods.

This is the case with deserts, in which the underground architecture of some settled peoples contrasts with the lightness of the shelters and tents of other nomadic peoples. In one case the heat from powerful solar radiation is fought by means of thermal inertia and darkness, and in the other with multiple screens against the sun and subtly controlled ventilation. Even in the most extreme climatic cases there are actually other factors apart from the climate which determine the solutions chosen.

In spite of this plurality of solutions, always limited by the basic constraints of the climate, it is interesting to observe how practically identical architectural models are developed in similar climates with highly different cultures and very distant geographical locations. This is what has led in many cases to the belief in the inflexibility of the connection between climate and popular architecture, to the point of converting it into a caricature of the real situation.

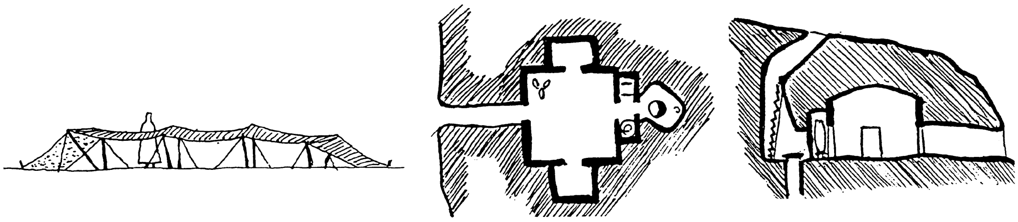

Fig. 5. Tuareg tent. *Mopti* Cave, West Sudan.

When underground dwellings very similar to Tunisian ones are found in Chinese deserts, or when the Malay longhouses prove to be practically identical to those built in the Amazonian jungle, we can start to believe, though wrongly, that the climate leads to typical building models that are limited in their economy of resources.

In any event this is not the case, and we have already seen how identical problems are solved in the same zone by different alternatives, something which enriches popular architecture extraordinarily. But there are also other points upholding the same arguments. It is even more interesting to find special architectural solutions that transcend from one place to other and from one culture to another, and are used with subtle variations to solve very different climatic problems.

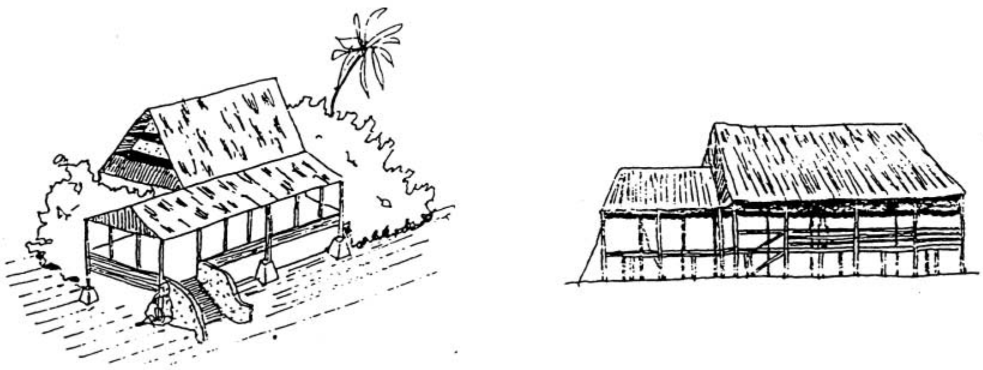

Fig. 6. *Yagua* house (Amazon). *Malaysian* house.

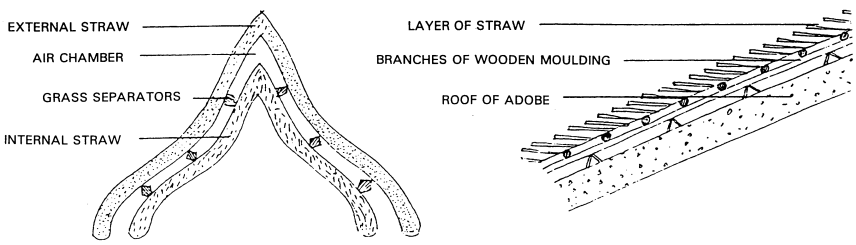

Fig. 7. Double roof: *Masa* housing (Cameroun), and *Orisa* housing (India).

This is the case of intermediate spaces in general and of the central courtyard in particular, as we will see below. We use the term intermediate spaces to mean those areas which do not strictly belong to the interior or the exterior of the building. Some examples of this type are porticos, balconies, galleries, vestibules and porches, in addition to the courtyards already mentioned.

All these spaces often fulfil important climatic functions, but they also have a strong symbolic role associated with them, outwardly expressing the feeling of their owners as well as having a flexible and diffuse utilitarian aspect which makes them multi-purpose areas and last resorts for any activity that does not have its own particular space in a building. Thus, over and above the climate, these spaces are used by everyone, demonstrating their marvellous capacity for adaptation.

The case of the courtyard is perhaps the most exemplary of all. The model of the house-courtyard as a detached residence or in dense urban situations is found in very diverse climates, changing its form and proportions to fulfil its climatic functions better in each case. The courtyard thus sometimes becomes a shady redoubt, protected from the wind and refreshed with the humidity of fountains and vegetation in warm-dry climates. It is also used to ventilate central zones of the building in wet climates, becoming a 'solarium' sheltered from winter winds in colder climates. And it is included within representative architecture in any climate as an ornamental element that reproduces the patterns of light and darkness of domestic architecture on a different scale.

This example, like others which we could put forward, once again demonstrates the mistake of considering the solutions of popular architecture to be limited. The great wealth of this kind of architecture lies precisely in the flexibility and adaptability of its solutions, which without ostentation attempt to express this wealth with the daily simplicity of the resources it uses.

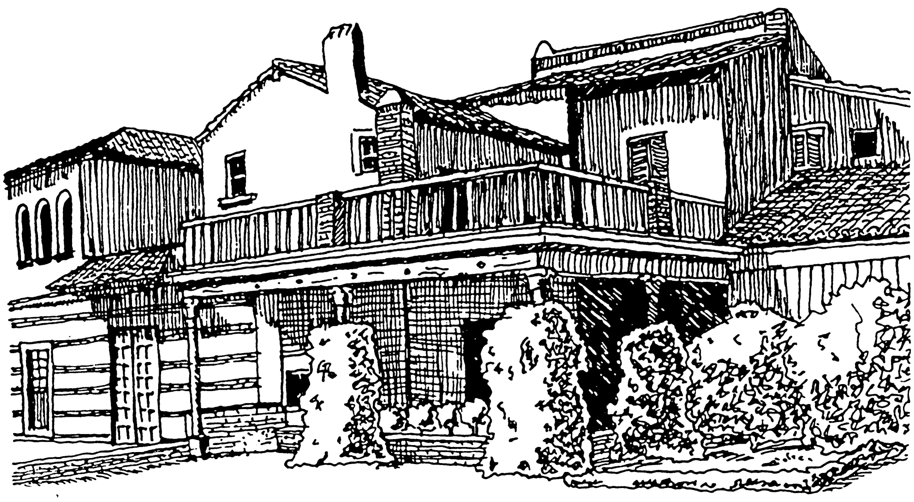

Fig. 8. Intermediate spaces between interior and exterior ambiences.

4. A singular solution—changes of location

This is a kind of solution which has had in the past, and may continue to have, special importance as a resource of environmental control.

There are many examples in the popular architecture of emigration or seasonal changes of residence. Normally connected with nomadic peoples that follow their herds in their annual search for fresh grazing land, these changes of residence are also linked to a desire to follow more favourable climatic conditions during the year. In this way the constructions can be simpler, adapted only to the climate of one part of the year, without needing to be adapted to the most extreme conditions which are avoided by moving.

The Paiuta Indians thus wintered in huts of a conical structure with a central oven and a hole for the smoke to get out, built with branches, wood and tree bark, and covered with branches or cane or grass fabrics. In summer their settlements were square without walls, with flat covers held up by four sticks, or more often they built shelters in a circular or semicircular shape, made with stakes or scrap of any kind, against which sand was swept up from the outside, with a fireplace and alcoves to sleep leaning against the wall inside.

In winter the shepherds of Siberia and Central Asia use tents covered with skins and snow piled up outside up to half their height, whereas in summer they use lighter leather tents. Sometimes they substitute the tents used in summer for cabins made of stone, wood and grass and in winter for semi-underground rectangular constructions, with the fireplace located opposite the entrance, walls and roofing a metre thick in earth, with grass for insulation and small windows made of animal gut.

The Mongolians have the ingenious solution of their typical yurt, built in such a way that it can easily be dismantled and transported on horseback. Its covering is made with a different number of layers of felt according to the season of the year.

The Kazaks of Central Asia, with a similar climate to the Mongolians, pitch their tents in the mountains in summer and gather in winter in towns located at the bottom of the valleys close to the forests, to protect them from the cold winds.

Similar systems, such as those used by certain American Indians or the ones used by the Japanese in the Neolithic age, consist in using light tents in summer and semi-underground dwellings in winter.

This long list of cases of seasonal changes of residence should not surprise us if we take into account the custom of changing residence in summer so widely found in our own bourgeois society. It is, however, interesting to see that in these examples there is often a marked change in the type of building according to the time of the year, whilst in our case this no longer happens, at least as far as differences in climate are concerned.

Another type of migratory solution, also forgotten in modern architecture, is that of a change in the use of spaces within the same building according to the time of year, or even from day to night. This was very frequent, and it still is in countries on the mediterranean coasts, where the very complexity of the climate makes this type of solution worthwhile. Though this system requires greater constructed volumes than in typical modern apartments, it permits an improvement in the flexibility of the

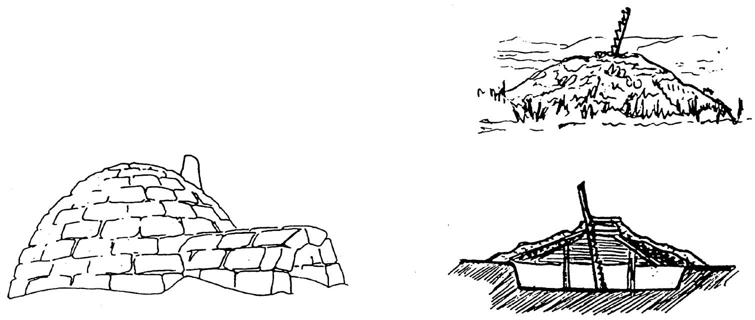

Fig. 9. Eskimo igloo, cold design. *Salish* shack (Canada).

architecture which makes it much more comfortable. Furthermore, it is indirectly more independent of artificial systems of environmental control, and therefore more economical with energy.

This concept is seen in many urban dwellings in Arab countries, where in summer they sleep on the roofs at night and take refuge in underground spaces during the day, while in winter the more conventional central spaces are occupied. In colder areas the zones of the dwellings used in winter are reduced as far as possible, leaving a whole series of intermediate spaces whose only purpose is to act as a supplementary thermal barrier against the outside weather. In summer or in the intermediate seasons, these intermediate spaces regain their full capacity for use in daily life.

This type of 'dual housing', with examples in the history of all the Mediterranean countries, normally had two kitchens, the winter one being in the innermost part of the dwelling to keep it warm, and the summer one outside to prevent heating of the cooler spaces inside. Dining rooms, studies and even different bedrooms, were similarly used in winter and in summer.

One of the challenges still pending for modern architecture is perhaps the recuperation of this concept of flexible occupation of buildings, and its transfer to other types of use apart from housing. In public buildings and office blocks this variable occupation and the intelligent development of intermediate spaces could well permit a more efficient use of architecture.

5. Typologies depending on the climate

5.1. Cold climates

In cold regions, the most important factor for the habitability of the buildings is keeping the heat trapped inside. This leads directly to a preference for compact built forms, with as few surfaces exposed to the outside as possible to reduce heat loss. In the most extreme case the forms of architecture become semi-spherical, seeking the maximum volume for the minimum shell surface, while in other cases the building is set underground, seeking the greatest possible protection. It is clear that these solu-

tions reduce the possibilities of ventilation and lighting in the interior, but once again the most critical condition of the architecture—in this case the cold—takes preference over the others in the definition of its general volumetry.

As a complement to the above features, popular architecture in these climates attempts to obtain the maximum possible insulating power of the enclosure walls, at the same time as a high level of airtightness to avoid draughts. Since in primitive technologies it is not easy to find insulating materials and hermetic openings, the result tends to be buildings in which the apertures are few and small, thus increasing still further the darkness inside. As it is difficult to obtain good insulation in opaque wall faces, complex and sometimes very ingenious strategies are used to improve the defence against the cold. Typical solutions found in these climates are the following:

- Using heaped snow on the roofs and walls of the buildings to benefit from its insulating power.
- Using granaries and lofts as heat barriers, storing straw in them to increase their insulating power.
- Using the heat produced by the kitchen, locating it in the interior of the building in a central position or in the coldest orientation of the house.
- Using the heat given off by the cattle, by locating the stables under the inhabited zone.

In addition to these specific solutions, which are common to most buildings in these zones, there are strategies of a more general nature for improving on unfavourable initial heat conditions.

The locations that tend to be chosen are hillsides facing the sun. The buildings are constructed in groups, seeking a compact formation in towns to obtain mutual protection against the cold winds, even though this is achieved at the price of lower access of solar radiation to the openings.

In most examples of popular architecture in cold countries, the collection of solar radiation for the purpose of heating is forfeited in exchange for better insulation. This voluntary loss of the possibility of solar heating and lighting has a proper justification which is sometimes hard to understand from our technological and cultural standpoint. The use of translucent or transparent materials in very low technology situations is very rare so, without the possibility of using the greenhouse effect of glass, the additional losses caused by an aperture are much greater than the gain in solar energy that could be obtained.

The Eskimo habitat can be considered as the most representative and exaggerated example of popular architecture in cold climates. In this case, the strategy of the use of openings to pick up solar radiation is approached through enclosure walls made of blocks of ice that allow a certain amount of radiation to get through. They are covered with opaque skins when the radiation is not of interest and improved insulation is sought.

Because of the constant and intense cold, and the intense winds of the zones close to the North Pole, the Eskimos typically live in igloos. These semi-spherical ice constructions have a raised floor inside in the occupied sector in order to use thermal stratification. The Eskimos cover the inside of the walls of this living space with skins,

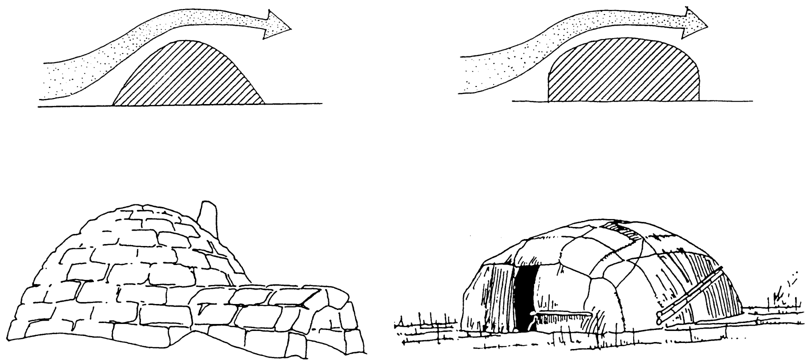

Fig. 10. Wind adaptation eskimo igloo and *mongolian yurt*.

creating air spaces that improve the insulation. In the centre of the space a small lamp burning seal oil is enough to keep the place warm.

In the summer, which is also cold, the Eskimos use partly buried dwellings. These are also circular in shape, with stone and earth walls up to a height of a metre and a half, and a narrow underground entrance. The floor inside is also on a higher level to that of the entrance, to cause a thermal siphon effect as in the igloo. The wooden beams are arranged in a radial pattern, and leave a central opening for the smoke to get out. They are covered and joined together by a double layer of seal skins filled with moss, thus achieving quite good insulation.

These Eskimo solutions are used with slight variations in the different zones inhabited by this race, though the underground habitat, less spectacular than the igloo, is sometimes used all year round with good heat efficiency. Another variation of the Eskimo habitat is the one found in Siberia, where in some cases they build rectangular cabins that have a wooden structure covered with a thick (1 m) layer of earth mixed with grass, which provides quite good insulation.

Aside from all the modalities of the Eskimo habitat, there are many more representative examples of dwellings in cold zones, with diverse variants of the general characteristics that we have defined above. Other examples of original cases could also be given, such as the outdoor covered corridors for communication between New England barns, the streets lined with porticos in the cities of northern Japan and Switzerland, the underground communication tunnels between Eskimo igloos, and so on. In these examples we find a curious parallel with the shady streets of certain zones of Arab cities or the underground connections in troglodyte districts of Turkey. All these are cases in which the environmental control goes beyond the scale of the building and reaches the urban scale.

5.2. Hot dry climates

In the regions with this type of climate an attempt is normally made to take advantage of the great temperature variation during the day-night cycle, delaying the

penetration of heat as far as possible so that it reaches the interior at night, when it is least bothersome. For this purpose materials of great thermal inertia are used, such as clay in the form of adobe bricks or mud walls, thick stone and all the possible combinations of these solutions.

Houses in these climates are frequently arranged in compact patterns, one very near to another, leaving small separations in the form of alleys or courtyards. Thus, the surfaces exposed to solar radiation are reduced and the built weight per unit of volume occupied is increased, which raises the thermal inertia of the ensemble. The generation of shade between neighbouring buildings reduces the warming of their walls by radiation and at the same time enables them to be cooled by contact with the fresh air at night.

In these buildings with great thermal inertia, the way their openings are handled is of vital importance: windows should be totally closed during the warmest hours of the day, not letting in either the light or the hot air from outside. At night these windows should be fully opened to use the cooling effect of nocturnal ventilation.

In some special cases in which thermal inertia cannot be relied on, such as the Tuaregs' tents in the desert, this independence of the internal air from the outside air is forfeited, and direct radiation is fought by being reflected and re-emitted through sophisticated barriers, with fabrics that are sometimes of dark colours and are cooled

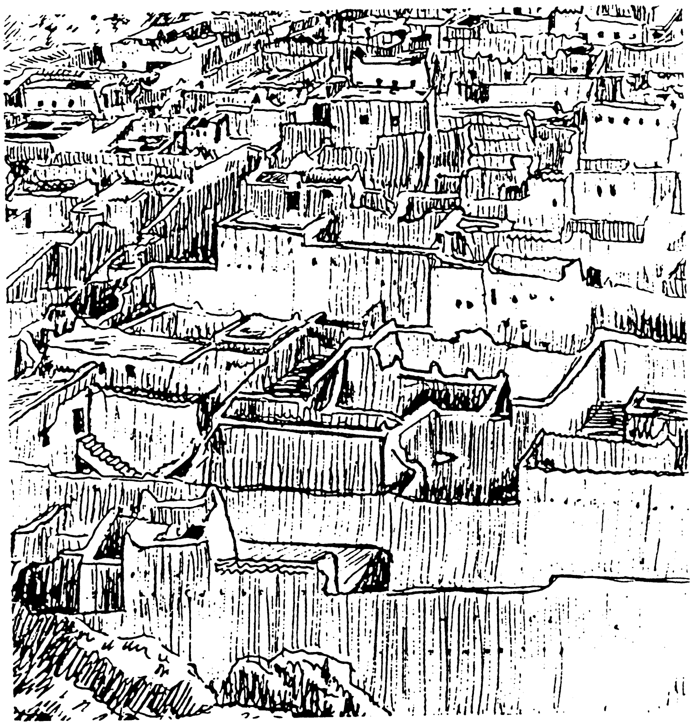

Fig. 11. Somalian village.

under the sun by the effect of the accelerated circulation of air that occurs within the fabric, preventing the re-emission of radiation toward the interior.

In the dwellings found in these climates the kitchen is located outside, thus avoiding adding heat to interior spaces which could worsen their living conditions. The outside of the buildings is painted white or in light colours that reflect the radiation as much as possible. The openings facing the exterior are few and of a small size, often set in the highest part of the walls to reduce the radiation on the ground, to help hotter air in the house to get out, and to obtain the best possible lighting with the minimum penetration of radiation.

In these regions the presence of water is very important, and for this reason an attempt is always made to retain rain water, protecting it from evaporation through storage in underground tanks below the dwelling. These tanks also increase the thermal inertia of the building and sometimes cool it through the evaporation effect which, though small, provides some continual damping and cooling for the floors of the houses.

Other resources used to reduce the effects of the sun on buildings are eaves, blinds and lattices in the openings, vegetation to protect from the radiation on the walls or on the paving of outside spaces, etc. Larger scale solutions are public spaces such as streets or squares, and even entire towns, covered with immense barriers against radiation by means of canvases, cane meshes, etc.

Another type of solution found all over the world is the construction of underground dwellings by digging caves where the land permits, seeking the temperature stability that is always found at a certain depth under ground level and creating much more inhabitable interiors.

Another element typical of the architecture of these climates, though it is also present in other environments, is the courtyard. The cooler damp night air is retained in these areas, keeping conditions pleasant during the day because the yard is protected

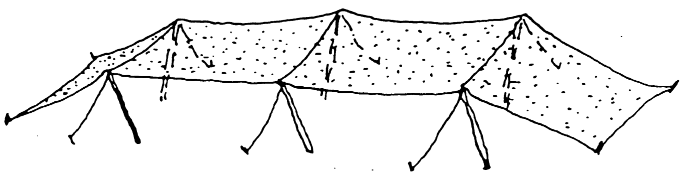

Fig. 12. *Tuareg* tent.

Fig. 13. *Yokurt* settling, collective protection.

from solar radiation, dry winds and sand storms. With the complement of water and plants, these yards become refreshing wells in the heart of the building.

In certain cases, especially in Arab countries, wise use is made of a combination of two courtyards, one in shade and the other sunny, to create a natural air flow from the cooler courtyard to the warmer one, creating an especially pleasant environment in the intermediate premises. In other cases, as in the Moroccan mountains, very high and narrow courtyards are built in buildings several storeys high, acting as inverted chimneys that ventilate the innermost zones of the building.

The basic design of the courtyard-house, which can be found in all types of cultures and climates, thus finds in warm-dry regions its best operating conditions and its greatest usefulness as a system of climatic improvement of architecture.

In the warm-dry climates of different zones of the Earth we often find similar buildings forms. For example, it is typical to use heavy enclosure wallings, adobe or mud walls or roofs of very great thickness. These are often justified by their structural function, but basically fulfil a climatic function, as is shown by the cases in which they act simply as a covering for load-bearing wooden structures.

Another typical solution in these regions is that of the double roof or double wall with a ventilated inner space. This is normally found in climates that are warm and dry for the greater part of the year but have a rainy season during which conditions approach those of warm-wet climates. In this case it is common to build enclosure wallings combining the use of straw and clay, with the following consequences:

(1) The straw layer, that has to be renewed annually, protects the lower clay layer from the water during the rainy season.
(2) the same straw protects most of the roof from the direct effects of the sun, avoiding heat storage and the indirect warming of the interior by radiation re-emitted during the dry period.

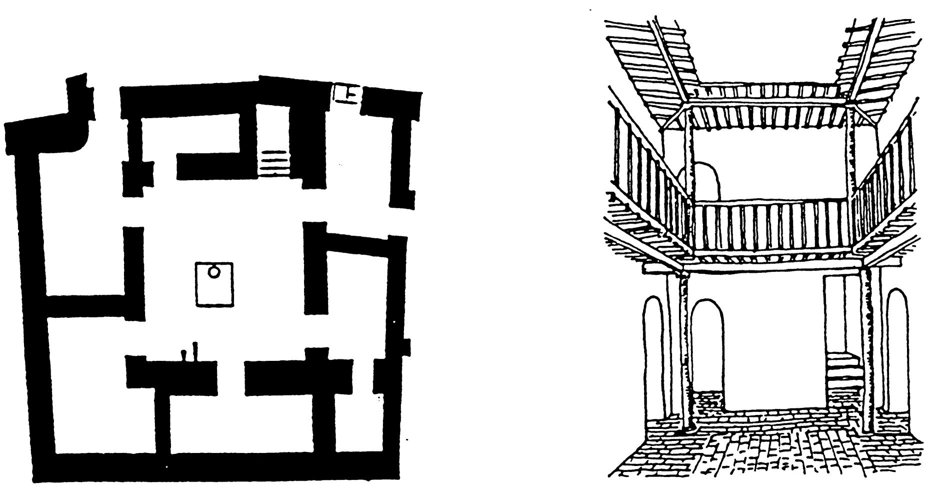

Fig. 14. Layout and courtyard of a housing in *Ur* (Mesopotamia).

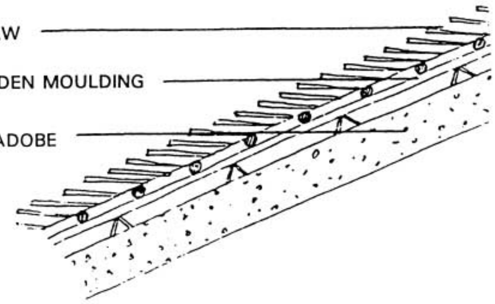

Fig. 15. *Orisa* housing (India).

(3) The empty space between the two layers offers additional insulation on very warm days and the clay layer, with its thermal inertia effect, regulates the inside repercussions of outside temperature variations.
(4) The inertia of the interior space is improved since the straw layer acts as an outer insulation for the wall faces, a situation that is theoretically the most favourable for thermal stability in permanently occupied buildings.

5.3. *Hot humid climates*

In this type of climate the thermal inertia of the buildings offers no advantage, since the variations in the outside temperature in the daily and annual cycle are very small. Furthermore, because the radiation is very intense, it is vital to obtain the maximum possible protection against its effects by attempting to stop not only direct, but also diffuse radiation, which is of importance in these climates.

On the other hand ventilation is also very important in order to dissipate the heat in the interior and to reduce the humidity of interior spaces. For this reason, the buildings have large openings protected from the sun, while the typical implantation of buildings uses long narrow forms that are independent and distant from each other, attempting not to create barriers for the breezes between the different buildings.

To make air circulation reach the whole interior space in these climates, apertures occupying the whole wall face are used to allow the air to circulate, with protection from radiation and onlookers by means of lattices, blinds, etc. In spite of these devices this solution logically entails problems of privacy and a total lack of protection from noise.

In traditional dwellings in these zones the roof is a very important element, since it has to act as a parasol and umbrella at the same time. In some cases the roofs are broken down into a great number of overlapping roofs, one shading the other, among which the air can circulate, thus avoiding overheating.

Also typical in these zones are roofs with a steep slope to drain off the frequent rains. They favour the thermal stratification of hotter air at the top, where openings are made to let this air out. The very accentuated eaves afford protection from radiation and from the rain. They also offer ventilation and sometimes form porches

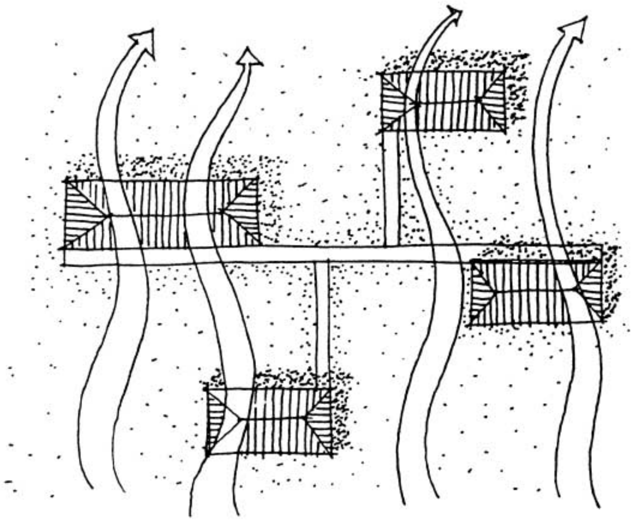

Fig. 16. Hot humid layout of buildings.

or open galleries, generating shady intermediate spaces by day and spaces protected from the cool damp air at night, which makes it possible to rest or sleep on very hot days.

In nearly all cases the roofs are light in order to avoid heat storage from radiation, with a composition that permits a certain ‘breathing’ of their strata to avoid condensation inside and favour cooling by air circulation. The floors of the buildings are raised in many cases, to obtain better exposure to the breezes, protection from floods in the event of storms, and protection against insects and small animals. These raised floors are built so that they are also permeable to the air, thus completing the ventilation facility of the whole envelope of the house.

A typical environmental solution of these climates, which we could consider to represent the minimal habitat, is the hammock. Used for sleeping or rest, these

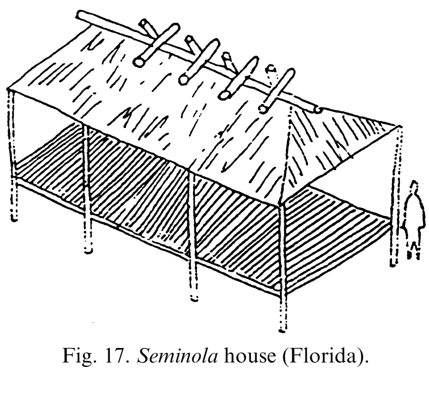

Fig. 17. *Seminola* house (Florida).

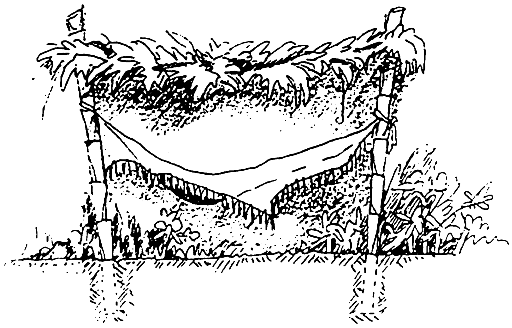

Fig. 18. Colombian hammock.

permit air circulation in all directions, and the swinging motion produces the relative movement of the air with minimum of effort. The hammock does not have any thermal inertia, as opposed to mattresses, which are uncomfortable in these climates. A complete example of this solution would be the typical Colombian 'habitas', made up of a roof of leaves on a structure that also serves as a support for the hammock and for baskets or sacks containing foods, water, etc.

To sum up, in these climatic zones the role of protection that we normally attribute to the building results in the most immaterial architectural constructions.

In these warm-wet zones, natural light can become much more bothersome than in warm-dry zones, since the sky produces a very intense brilliance in all directions, easily causing dazzling effects. For this reason, the openings are often covered with dark coloured cane meshes that reduce the brightness penetrating the interior from the surface of the openings. The ceilings are painted white to distribute the light as evenly as possible in the interior. This same function is performed by the lattices and grilles found in Arab countries and the galleries and balconies that act as areas of shade and protected extensions of the indoor area towards the public space.

In the zones where the damp heat is only seasonal, housing design can become relatively more complex. Sometimes in urban zones very high ceilings are used, where the hot air is stratified and the air in the lower part of the rooms, which is the occupied part, is cooler. In other cases, in the event of changing from wet to dry heat, houses are built with a light structure covered with canvases or awnings, which in the dry season contract and allow air to circulate among their fibres, and which dilate in rainy conditions to form almost waterproof, compact meshes.

5.4. Windy climates

Air movement is connected with the sensation of heat, thus becoming a positive factor for comfort in warm-wet climates and a clearly negative one in cold climates. However, excessively strong winds are unpleasant in any type of climate, and can in extreme cases become the main conditioner of the forms of popular architecture.

The simplest and most primitive system of controlling the effects of wind is found

in the simple windbreaks, built with branches, straw or grass, that are found as a primary model in all cultures that take their first steps towards civilization. Shelters of this type are still found in the 20th century as a habitat of Australian aborigines.

The basic form of these windbreaks is an inclined plane that is located in the direction of the wind and provides protection for people and for the fire used by them, whilst also giving some protection against rainfall.

Other primitive peoples also use more or less sophisticated shields for shelter from the wind, as in Samoa or in South Africa, where the Khoisan move large screens about to close up the walls, raising or lowering them according to the direction and the intensity of the wind.

Another more elaborate example of controlling the effects of wind is the case of the Arab tent, which is erected only to a limited height and is protected from the wind by mobile barriers anchored in the sand.

Different peoples that lives in zones with intense winds, such as the Eskimos or the Siberian Mongolians, make their buildings with rounded forms close to semi-spherical shapes, which are the ones that offer the least resistance to wind.

When choosing locations for their igloo settlements, Eskimos also seek sites protected from the wind by cliffs, with the entrance to their dwellings facing the beach. These entrances are built in the shape of a curved tunnel to prevent the direct entry of the wind. The mouth is set transversely to the dominant direction of the wind and is protected with a wall of compressed snow blocks.

Another sophisticated habitat solution that controls the action of the wind is that of the American Indians' tepees, which with two large flaps on the upper part of the tents, worked with two long sticks from ground level, direct the opening in the most suitable direction according to the weather conditions.

If we seek examples closer to the European culture, there are many buildings from popular architecture whose form is clearly influenced by the presence of a dominant wind. This is the case of Norman farms, in the northwest of France, whose cane and

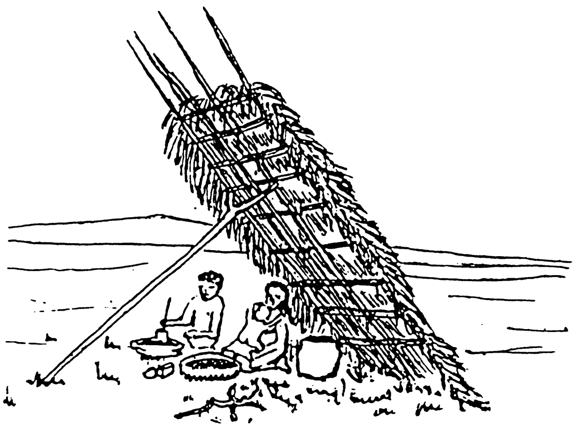

Fig. 19. *Bushman* windbreaks (Austral Africa).

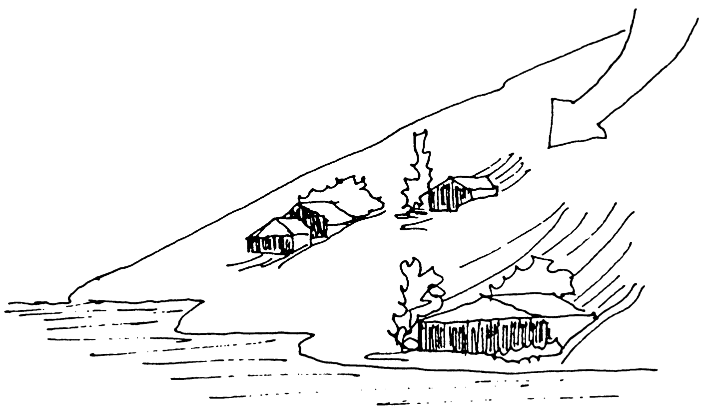

Fig. 20. Switzerland houses.

straw roofs have shapes similar to the hull of a ship, with the prow facing the hostile Atlantic wind and the stern extended to create a protected zone toward the east.

In Italy, in the village of Pescontanzo in the Abruzos mountains, the houses set between partition walls have very pronounced eaves, that are supported on the prolongations of the divided walls, thus covering and protecting from the intense wind of the zone not only the outdoor staircases, but also the small windows and doors set into the facades.

Finally, in many other zones with intense winds, such as French Provence or the Swiss valleys, houses are dug into the hillsides of the mountains facing north, helping to divert the wind over the roofs and creating a protected zone on the southern side.

5.5. Complex climates

As we have already mentioned above, temperature climates often have very variable conditions throughout the year, which force popular architecture to use much more complex solutions than in the case of the more extreme climates. This complexity is made manifest in the use of flexible systems, with elements or combinations of elements of the building that can easily change their environmental action according to the weather conditions. The most typical of these flexible systems are:

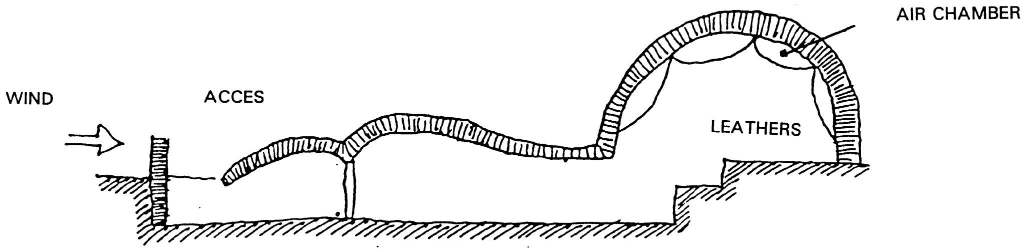

Fig. 21. Section of an igloo.

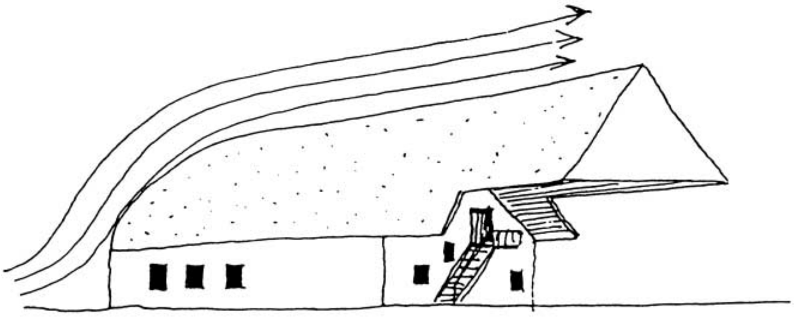

Fig. 22. Normand farm.

- Mobile shade systems, such as the typical louvre blind that allows the entry of radiation and ventilation to be controlled simply and conveniently.
- Mobile insulation in the openings, shutters, curtains, etc., which enable the flow of heat and light to be regulated, above all in winter.
- Apertures that can be completely opened, permitting maximum control of ventilation and allowing the free passage of air and sunlight when appropriate.
- Intermediate spaces between indoor and outdoor areas, which can generate favourable microclimates, as has already been mentioned above. These can also be occupied at different times of day and seasons of the year, thus adding to the building's functional possibilities.

With this great number of resources, the popular architecture of temperate climates in general, and the Mediterranean climate in particular, solves the difficult problem of using one sole architectural form to resist differing climatic conditions that, though to a lesser extent, reproduce the characteristics of the extreme climates analyzed above.

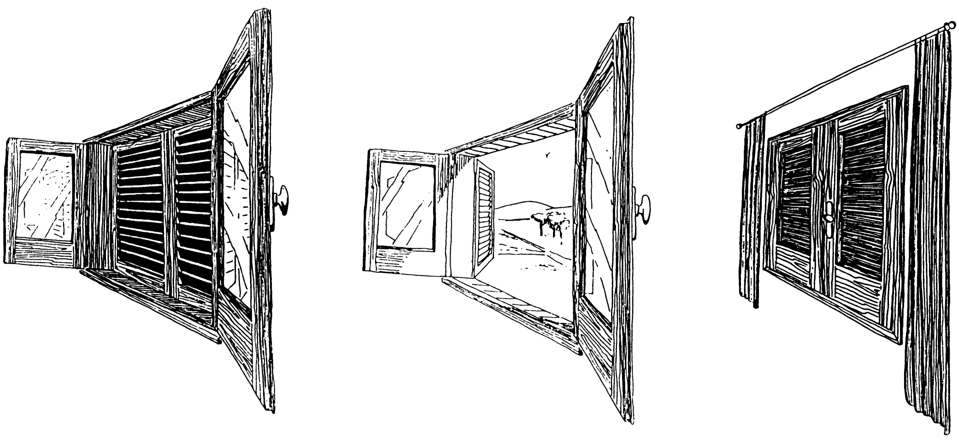

Fig. 23. Movable shading systems, movable insulation and completely practicable openings.

These climates have the problem of cold in winter, which can be dry or wet; though this distinction was of no importance in very cold climates, it involves different solutions here. They can also be very hot in summer, with high or low humidity, at times with the same intensity as the examples dealt with above, though these weather conditions last for shorter periods. Finally, there is the problem of the intermediate seasons, spring and autumn, where in short periods of time the climatic conditions can change from one extreme to another.

Though all these situations may not be critical separately, taken as a whole they have given rise to this complexity and wealth of solutions in popular architecture in these climates, which in fact makes it more complicated than that of more extreme environments.

When challenged by climatic changes, architectural solutions become more complex, seeking in the relationship between interior and exterior an energy operation that we call a ‘filter’ between different environmental conditions, instead of using most solutions of the ‘barrier’ type that we have found in simpler and more aggressive climates.